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THE IOWA ALGEBRA APTITUDE TEST ADMINISTERED IN THE EIGHTH GRADE AS A PREDICTOR OF SUCCESS IN HIGH SCHOOL MATHEMATICS, GEOMETRY AND ABOVE

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CHAPTER I

THE PROBLEM AND DEFINITIONS, ASSUMPTIONS, AND PROCEDURE USED

With the technological and scientific advances being made by society, the study of mathematics is becoming increasingly important. A 1964 Government pamphlet, Mathematics and Your Career, encouraged students to take all of the mathematics they can get in high school. This statement was intended not only for students contemplating a career in mathematics, but also for many others whose intended careers would require various degrees of mathematical training.[1] According to Harl R. Douglass, Professor of Secondary Education, University of Minnesota, it is not only important that youngsters are well trained in mathematics and mathematical sciences, but that pupils with mathematical talents have every opportunity for the earliest possible development of their talents.[2] It is important, therefore, to identify those students who have mathematical abilities as early as possible and to encourage them to study mathematics.

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[1]United States Department of Labor, Bureau of Labor Statistics in cooperation with the Department of Health, Education and Welfare, Mathematics and Your Career (Washington: Government Printing Office, 1964).

[2]Harl R. Douglass, "Issues in Elementary and Secondary School Mathematics," The Mathematics Teacher, XLVII (May 1954), 295-98.

Guidance counselors and the mathematics instructors at Urbandale High School, who have attempted early identification of mathematically talented students, have encountered other problems which make it important to find a reliable tool to aid in the identification of those with mathematical abilities. Each year, several apparently capable students are frightened by the rigor of mathematics and elect not to enroll in higher mathematics courses. Other students who are capable, elect to take a mathematics course, but are frightened during the first two weeks and drop the course. There are also some with more nerve than ability who elect to stay in a mathematics course where satisfactory work is almost impossible for them. A reliable tool is needed to identify the students for purposes of counseling and also to aid in selecting students for classes that are grouped according to ability.

I. THE PROBLEM

The writer was asked by the Urbandale guidance counselor and the school administration to evaluate the Iowa Algebra Aptitude Test, ordinarily administered to eighth graders during their second semester, as an indicator of success in high school mathematics. It was the opinion of the writer that the Iowa Algebra Aptitude Test could be used to predict success in high school mathematics above first year algebra. The purpose of this study was to examine each student's performance in mathematics as related to his composite percentile score on the algebra aptitude test. If a reasonable relationship was found, the intent was to expand the problem to one of putting the relationship into a form so that test scores could be used as predictors of future performance in mathematics.

The problem was not to evaluate the Iowa Algebra Aptitude Test as the only tool to be used in predicting success, but as a tool to be used in conjunction with any other pertinent information a guidance counselor or teacher might have available. The use of predictive tools with other pertinent information was suggested by the writer's four years of teaching experience which have shown intellectual ability, subject interest, academic interest, and student-teacher rapport as well as raw mathematical ability to be important factors contributing to the successful study of mathematics. For this reason, the final answer to the question of the test's usefulness, as an aid to predicting successful mathematical achievement, must be left up to the one using it.

Eight central Iowa high schools were selected for this study. The schools selected consisted of two suburban Des Moines schools, two middle-sized county seat schools, and four small rural community schools. Their graduating class sizes varied from twenty-two up to two hundred and forty-six. The two most recent graduating classes which had been administered the Iowa Algebra Aptitude Test were used, with two exceptions where data was available for only one class. Scores and grades were used for students who had taken the algebra aptitude test in eighth grade and at least one high school mathematics course having first year algebra as a prerequisite. Students' first year algebra grades were not included in this study. Only the composite scores earned on the algebra aptitude test were used. Part scores were not considered. The data used was compiled in June, 1965 and derived from classes which graduated in 1963, 1964, and 1965.

II. DEFINITIONS OF TERMS USED

For clarity and better understanding, certain terms were defined as follows:

Higher mathematics course. Any high school mathematics course that has first year algebra as a prerequisite.

Geometry course. Any mathematics course given to high school students, generally sophomores, based on Euclid's or other more recent and rigorous sets of principles, and listed in the school's schedule of courses as Plane Geometry, Plane and Solid Geometry, Euclidean Plane Geometry, Geometry, or other similar titles.

Advanced algebra. The next mathematics course in succession, other than geometry, that has first year algebra as a prerequisite. This course is not necessarily restricted to algebra, but might also include some trigonometry and analytic geometry.

Senior mathematics. Any mathematics course that directly follows geometry and advanced algebra in a sequence of progression.

College preparatory mathematics course. The course offered to high school seniors who are in an accelerated program that allows them to take four rather than the customary three mathematics courses above first year algebra.

Superior achievement. An overall mathematics grade average of 2.75 or higher based on an "A" equals 4 points system.

Successful achievement. An overall mathematics grade average of 1.60 to 2.74 based on an "A" equals 4 points system.

Unsuccessful achievement. An overall mathematics grade average of less than 1.60 based on an "A" equals 4 points system.

III. GENERAL ASSUMPTIONS

Two general assumptions were made at the beginning of this study. As mentioned earlier, it was assumed, on the basis of actual mathematics teaching experience, that various elements besides the abilities tested by the Iowa Algebra Aptitude Test are important contributors to the successful study of mathematics. As will be pointed out, this assumption appears tenable on the basis of current literature on the subject.

The second assumption was that if a useful relationship existed between the composite percentile score earned on the algebra aptitude test and a student's achievement in mathematics it would be of the type that a higher test percentile score would indicate a higher probability that the student would perform successfully. These two assumptions influenced the selection of the method of collecting, analyzing, and presenting the data of this study.

IV. PROCEDURE

There were three general points of interest in evaluating the IAAT, (Iowa Algebra Aptitude Test), as a tool for predicting future mathematical achievement. Is there a correlation between a high score on the aptitude test and achievement? Are there distinct dividing points between scores which imply success, possible success, or failure? And finally, if the first two questions are answered affirmatively, can the relationship be presented in a manner that is meaningful and useful to teachers, counselors, and students?

Several tables and comparisons were developed to answer these questions. Initially, the data was tabulated indicating a student's percentile score on the aptitude test, each grade that he received in each course and his overall average, grouped as superior, successful or unsuccessful. Using this tabulation, several comparisons were made. The scores were divided into percentile groups of five, (i.e. 95 percentile through 99 percentile), and the percentages of students from each group earning the various course grades and overall averages were computed. The percentage of the various grades in each subject and overall averages made by each percentile group were also computed. Another comparison was made to determine the minimum percentile score necessary to have a certain percentage chance, listed by increments of ten, of making superior or successful achievement. One other comparison was made where the range of percentile scores for students earning various grades in each course was listed.

CHAPTER II

REVIEW OF THE LITERATURE

A review of the literature revealed three types of information that were useful in this investigation. Information concerning the various qualities that appeared important for the successful study of mathematics was available. Studies of several indicators to predict success at various levels of high school mathematics have been done. The results of two studies concerning the IAAT itself, in addition to a complete and impressive explanation and validation of the test as found in the Examiner's Manual, were available.

Reviewing the literature showed that several factors contributed in varying degrees to successful achievement in high school mathematics. These include raw mathematical ability, intelligence, maturity, previous achievement, attitudes, and socio-economic conditions. Douglass found arithmetic and numeric reasoning, I.Q. and previous achievement to be important factors related to success.[1] These factors as well as problem solving, verbal, spacial and abstract reasoning abilities were reported as important by

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[1]Harl R. Douglass, "The Prediction of Pupil Success in High School Mathematics," The Mathematics Teacher, XXVIII (December 1935), 489-504.

Emma L. Benson in her study. She also reported interest and industry as important factors in success.[1] Lucille D. Wilson pointed out in her study that spatial relationship, abstract reasoning and numerical abilities are significant contributors to successful achievement in high school mathematics.[2]

Knowing the various factors listed above as significant, several studies have been done to evaluate those factors singly or in combination as predictive tools. Unfortunately, for the purposes of this study, most of the other investigations have been concerned with predicting success in geometry on the basis of indicators taken in the ninth grade. Benson's study of various ninth grade measures used to predict success in geometry did provide some results of interest. In comparing the scores earned on several tests taken by ninth graders with their results on a geometry achievement test she obtained the following coefficients of correlation: Non-Verbal Intelligence Quotient, .6610; Large-Thorndike I.Q., .5065; Problem Solving Score on Metropolitan Achievement Tests, .4928; Verbal Ability Sub

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[1]Emma L. Benson, "A Study of Various Measures in the Junior High School as Predictors of Success in Geometry" (unpublished Master's thesis, Mankato State College, Mankato, Minnesota, 1963), pp. 27, 28, 40-42.

[2]Lucille D. Wilson, "A Study to Predict Success in Mathematics for Students in the Secondary Schools of Dodge City, Kansas" (unpublished Master's thesis, Fort Hays Kansas State College, 1962), p. 33.

Test of DAT, .3435. She concluded that I.Q. test scores along with other criteria could be useful for predicting success in geometry.[1]

Wilson's study of students of the secondary schools of Dodge City, Kansas, indicated that achievement in high school mathematics can be predicted with a fair degree of success by using measures applied in the eighth grade. She compared scores made on various subtests of the Differential Aptitude Test, (DAT), with the score made on the Kansas Comprehensive Examination Subtest in Mathematics. To predict future success, Wilson was able to develop several regression equations with coefficients of correlation ranging from .60 to .66 and standard deviations from 3.95 to 4.14 using numerical ability, abstract reasoning, and spatial relationship raw scores from the DAT subtests. She had the following to say about one of these for predicting achievement:

> To predict a score on the Kansas Senior Comprehensive Examination subtest in mathematics, multiply the score made by the student on the Numerical Ability subtest of DAT by .285, the score made on the Abstract Reasoning subtest by .071 and the score made on the Spatial Relationship subtest of DAT by .042. Next add these three products to the constant 4.83. The odds are 2 to 1 that the actual score will not deviate more than ± 3.95 from the predicted score.[2]

The general conclusion as expressed in Wilson's study

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[1]Benson, *op. cit.*, pp. 40-42, 52.

[2]Wilson, *op. cit.*, p. 25.

was that significant relationships were found between the achievement scores earned on the mathematics subtest of the Kansas Senior Comprehensive Examination and the three subtests; Numerical Ability, Abstract Reasoning, and Spatial Relationships, of the Differential Aptitude Test administered in the eighth grade.[1]

With the number of significant factors of success that have been mentioned, it seems obvious that no single item or test could be used, with any high degree of accuracy, to predict future achievement in mathematics. The Cleveland, Ohio schools found that even with well-trained and experienced guidance counselors and teachers they definitely needed more than one variable to predict a student's future mathematical achievement. A need for a combination of indicators was evident. A good prognostic test, specifically the IAAT, was a very important part of the combination of variables chosen by the Cleveland schools to predict success.[2]

Douglass found a combination of factors rather than any one variable is needed for successful prediction. He was able to arrive at several important conclusions. First, he found that a student's achievement can be predicted with

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[1]Wilson, op. cit., pp. 26, 33, 34.

[2]Ona Kraft, "Methods Used in the Selection of Pupils for the Study of Algebra and Geometry in Cleveland," The Mathematics Teacher, XXXIX (May, 1946), 236.

a fair degree of accuracy. Second, he found that:

> Achievement cannot be predicted satisfactorily from any one variable for the purpose of homogeneous or ability grouping or definite advice relative to taking algebra or geometry.

Third, he found that a good combination for successful prediction included a good prognostic test, I. Q., and the average mark for the previous year or two years of work.

In his final conclusion, the following variables in order of validity were listed by Douglass. A good prognostic test was first, closely followed by the average mark of the previous year. I. Q., the previous teacher's estimate of a student's mathematical ability, and mental age, all of approximately the same importance, were listed next. Then came the achievement test score or grade of the previous year's mathematics work, chronological age, character trait rating, and socio-economic status, all of about equal weight.[1]

The results of two evaluations of the IAAT itself were available. Ona Kraft evaluated the test as one of a combination of indicators used by the Cleveland schools to predict achievement in first year algebra. The IAAT was administered to the eighth graders during the fifth week of the second semester. The following guidelines were established for using the results in advising students and

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[1]Douglass, "The Prediction of Pupil Success in High School Mathematics," op. cit., p. 492.

parents. It was felt that a student with a raw score of 55 or higher would surely succeed, a student having a raw score of 37 to 55 would be in a "maybe" category, and, a student below 37 should be strongly urged not to take algebra.[1] Since the norms in the Examiner's Manual are set up for taking the test in May and these students took it some two months earlier, the standards, in terms of percentile scores, can only be estimated.[2] It is logical to conclude, though, that the actual percentile scores would be somewhat higher than the May conversion scales which were used to convert the raw scores to percentile scores. The "surely" group was 65 percentile and up, the "maybe" group was 26 percentile up to 64 percentile, and the "no" group was 25 percentile and lower.

In checking these standards against actual achievement, Kraft found them to be realistic. At one school with seventy-two students taking first year algebra, 85 per cent of the "A" and "B" grades came from the "surely" group. One student from the "no" group took the course and earned a grade of "D." At another school with ninety-one students in first year algebra, 73 per cent of the "A's" and "B's" came from the

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[1]Kraft, op. cit., p. 237.

[2]Harry A. Greene and Alva H. Piper, The Iowa Algebra Aptitude Test, Examiner's Manual, Bureau of Educational Research and Service, State University of Iowa (Iowa City: Bureau of Educational Research and Service, 1942), p. 18.

"surely" group and 22 per cent from the "maybe" group. It was concluded that the IAAT was a useful tool to predict success in first year algebra in the Cleveland Schools. It is also clear that other factors were considered important in predicting achievement for students especially those with raw scores of 37 to 55, or the "maybe" group.[1]

Another study evaluating the IAAT as a predicting tool has been done. Martha S. McCabe studied the effectiveness of the test in selecting students for an accelerated mathematics program in the secondary schools of Greenwood, South Carolina. The IAAT was administered to selected seventh graders two weeks before the end of the school year. A raw score of 60 was arbitrarily set as a dividing line for selecting students for the advanced program. Students who had scored less than 100 on the California Mental Maturity Test did not take the IAAT and were not considered for the accelerated program. Besides having a relatively low I. Q., it should be noted that none of these students had done exceptionally well in any previous mathematics work.

Several exceptions to the sixty point dividing line for selecting those students who did take the aptitude test were made. Four of the forty-four students who scored 60 or better were not selected on the basis of poor previous

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[1]Kraft, loc. cit.

achievement and attitude. Thirteen students with scores below 60, but with I. Q.'s above 110 and "A" or "B" average grades in seventh grade arithmetic were selected.

McCabe divided the initial group of fifty-two students in the accelerated program into two parts; Group A, those thirty-nine students who scored 60 or higher, and, Group B, the thirteen who scored below 60 on the IAAT. Using these two groups, she then examined the achievement of both groups to see if those in Group A achieved significantly better than those in Group B.

She used "T" scores to conclude that, although the mean average grade of the Group A was higher than that of Group B, the difference could have been due to chance. She did conclude, however, that the achievement of Group A as indicated by the Sequential Tests of Educational Progress Achievement Test and trigonometry grades was significantly higher than Group B's achievement. This was not due entirely to chance. McCabe further concluded that a raw score of 60 on the IAAT should be given serious consideration as a tool for predicting continued success.[1]

According to the Examiner's Manual, the IAAT itself

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[1]Martha S. McCabe, "An Analysis of the Effectiveness of the Iowa Algebra Aptitude Test in Selecting Students for an Accelerated Mathematics Program" (unpublished Master's thesis, University of South Carolina, Columbia, 1963), pp. 1-11.

is the result of extensive study and testing. It has four parts. Arithmetic ability is tested by examples covering addition, subtraction, multiplication, and division of whole numbers, fractions, and decimals. Problems on percentage and United States money are also included. Abstract computation is tested. Numerical Series is the third area tested and Dependance and Variation is the fourth.

The test has been thoroughly validated and correlates very favorably with other prognostic tests. Extensive evaluations have also shown the IAAT to have a high degree of reliability.[1]

The literature showed general agreement concerning prediction. Several qualities appeared important to the successful study of high school mathematics. The more important qualities are raw mathematical ability, intelligence, and previous achievement in mathematics. Studies have shown problem solving, spacial relations, abstract reasoning, and numeric reasoning as important parts of a prognostic test to measure raw mathematical ability. Prognostic tests, I. Q. tests and previous grades have been shown to correlate well with various measures of mathematical achievement.

There was agreement that, while no one factor alone

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[1]Greene and Piper, op. cit., pp. 5-11.

can be used to predict future success with accuracy, a combination of indicators can be used for effective prediction. A good prognostic test appeared to be most valuable with I. Q. scores and previous grades also of considerable importance. The two evaluations of the IAAT both agreed that it is a useful tool for prediction.

Although much has been written about prediction, two limitations appeared. A great deal is known about the factors that contribute to success, but there was very little specific information that could be used in advising students about their chances for success. There was a lack of information concerning scores on various ability measures and interpreting the scores as being in a "will succeed," "might succeed," or "will not succeed" group. The other limitation was that very little is known about predicting several years in advance, not just for the next year.

CHAPTER III

PRESENTATION OF DATA

As indicated earlier, there were three main points to be considered in evaluating the IAAT as a tool for predicting future achievement in mathematics. It was to be determined if a positive relationship exists between percentile test scores and achievement, if there are distinct points of division for predicting levels of achievement, and if the relationships can be expressed in a manner meaningful to guidance counselors, teachers, and students in terms of helping students decide on a course of study.

I. POSITIVE RELATIONSHIP BETWEEN IAAT AND ACHIEVEMENT

Table I and Figures 1 through 3 were presented for determining whether there was a positive relationship between percentile test scores and achievement. Before discussing the data presented in them, comments are appropriate about what would be expected if a perfect relationship between the IAAT and achievement in mathematics were present.

The expectations are related to the following general baselines for grading, derived from the normal probability distribution. A positive standard deviation of 1.5 is approximately equivalent to the 93rd percentile. A

TABLE I

PERCENTAGE OF THE TOTAL OF EACH LETTER GRADE EARNED IN EACH COURSE BY STUDENTS IN EACH PERCENTILE GROUP

%ile	Geometry					Advanced Algebra					Senior Mathematics				
Group	A	B	C	D	F	A	B	C	D	F	A	B	C	D	F
95-99	28.8	13.7	3.9	1.9	9.0	36.4	14.6	9.1	2.8	0.0	40.2	26.2	14.4	3.3	25.0
90-94	27.9	24.7	10.0	0.9	0.0	29.4	26.0	10.4	10.1	0.0	28.3	21.6	16.3	20.0	25.0
85-89	13.4	12.8	9.2	5.4	0.0	14.7	13.8	14.5	4.6	0.0	17.4	22.3	13.4	10.0	0.0
80-84	10.5	11.0	16.4	7.4	0.0	6.2	18.1	14.1	12.1	10.0	7.6	13.1	19.2	20.0	0.0
75-79	9.5	12.2	16.2	5.9	18.2	5.4	9.8	16.5	12.1	20.0	4.3	5.4	16.3	0.0	0.0
70-74	3.0	7.4	12.9	11.3	0.0	4.7	5.1	6.7	11.1	0.0	0.0	2.3	4.8	6.7	25.0
65-69	3.5	6.3	8.3	11.8	0.0	1.6	4.3	8.8	14.9	0.0	0.0	2.3	6.7	16.7	0.0
60-64	1.5	2.4	7.4	14.8	18.2	0.0	2.8	8.1	8.3	10.0	1.1	2.3	1.9	20.0	25.0
55-59	0.0	1.8	3.1	6.9	0.0	0.0	0.4	1.7	3.7	0.0	0.0	0.0	1.9	0.0	0.0
50-54	0.5	2.1	4.1	8.4	0.0	0.0	1.2	5.4	4.6	20.0	0.0	0.8	2.9	0.0	0.0
45-49	1.0	3.6	2.4	5.4	0.0	1.5	2.0	2.0	6.5	10.0	0.0	3.1	0.0	0.0	0.0
40-44	0.5	0.9	3.1	5.4	36.4	0.0	1.2	0.0	3.7	20.0	0.0	0.0	1.0	3.3	0.0
35-39	0.0	0.3	1.3	3.4	9.1	0.0	0.0	0.7	0.9	0.0	0.0	0.0	0.0	0.0	0.0
30-34	0.0	0.9	0.7	4.9	0.0	0.0	0.8	1.3	4.6	10.0	1.1	0.8	1.0	0.0	0.0
25-29	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20-24	0.0	0.0	0.7	4.9	9.1	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5- 9	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0- 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Totals	100.1	100.1	100.1	100.2	100.0	99.9	100.1	100.0	100.0	100.0	100.0	100.2	99.8	100.0	100.0

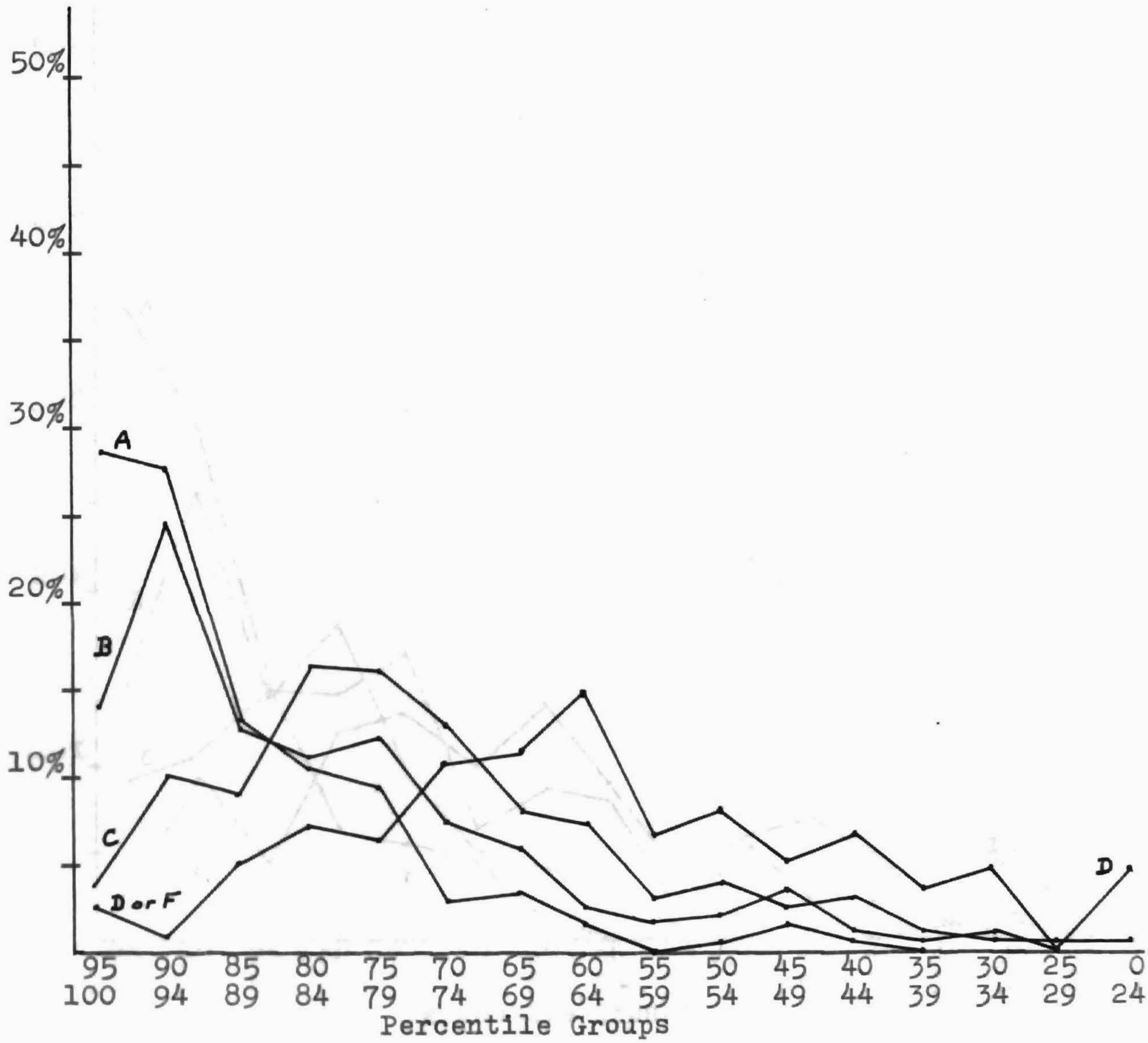

Figure 1. Percentage of each letter grade in geometry earned by each percentile group.

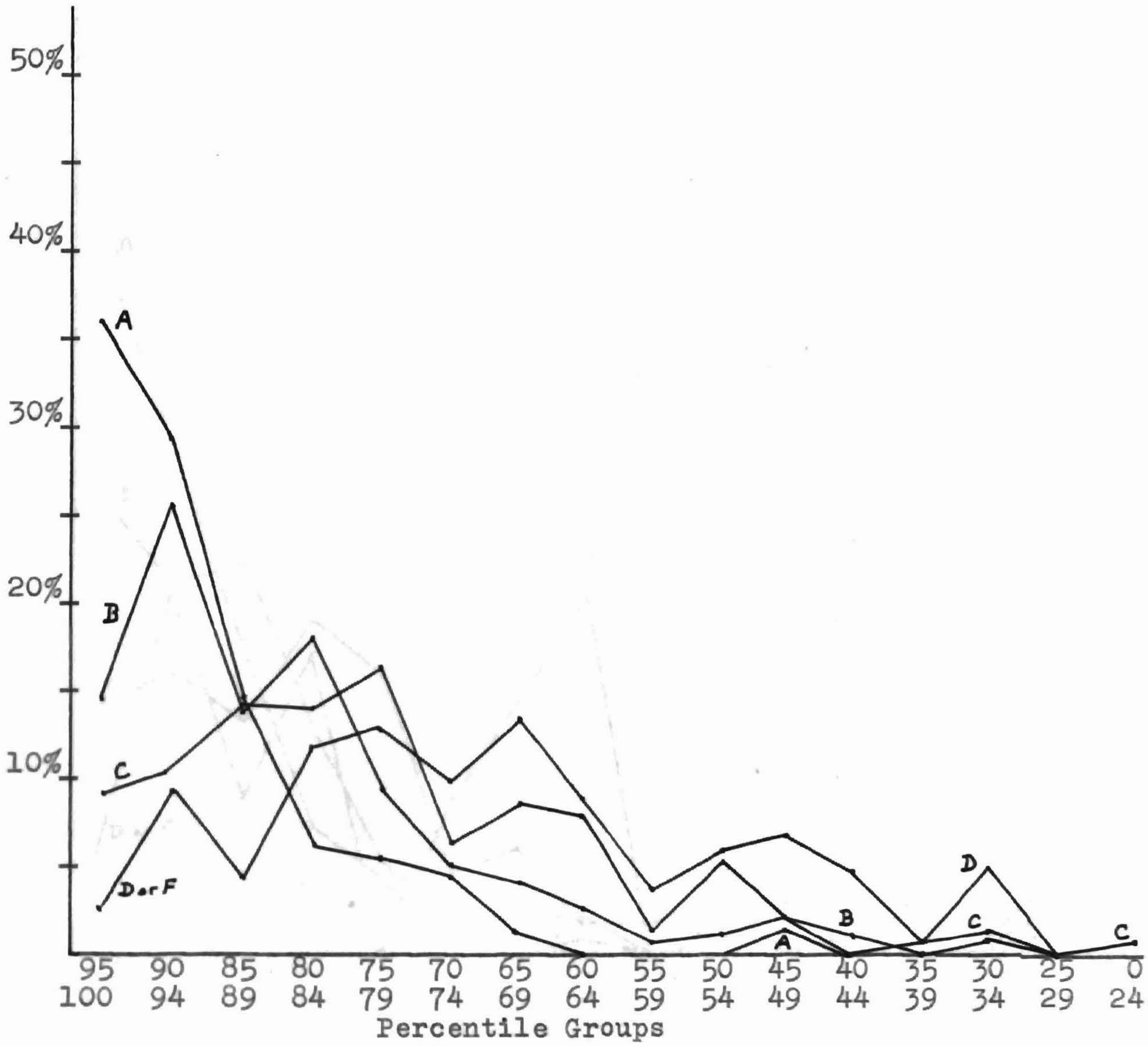

Figure 2. Percentage of each letter grade in advanced algebra earned by each percentile group.

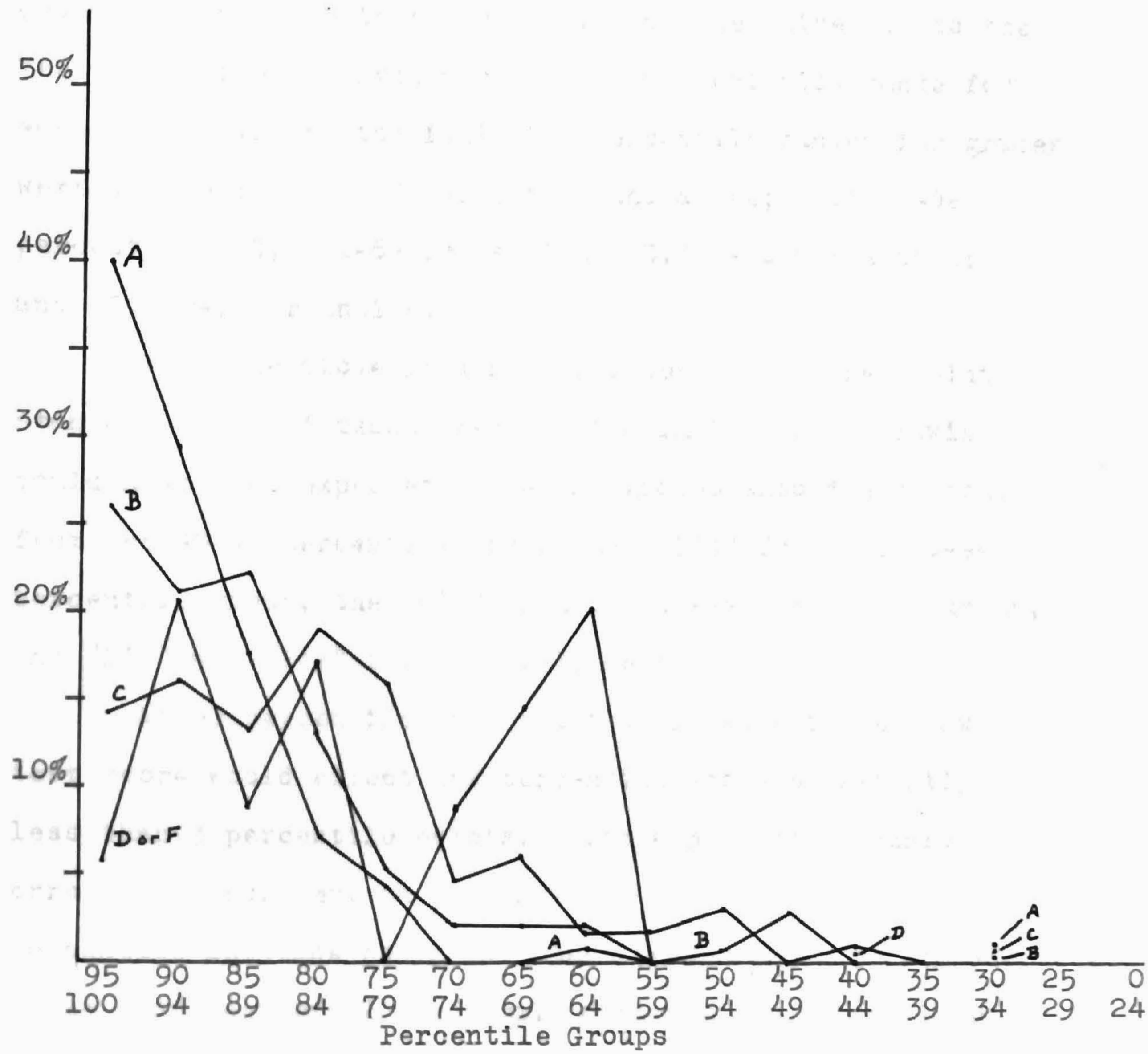

Figure 3. Percentage of each letter grade in senior mathematics earned by each percentile group.

positive standard deviation of .5 is approximately equivalent to the 70th percentile, a negative .5 standard deviation to the 40th percentile, and a negative 1.5 to the 7th percentile.[1] Given a one standard deviation range for each letter grade, the following percentile ranges for grades were derived: "A," 93 percentile and above; "B," 70-92 percentile; "C," 31-69 percentile; "D," 8-30 percentile; and "F," 0-7 percentile.

With the above grading baselines and a three point standard error of measurement on the IAAT,[2] the following could have been expected. The "A" grades should have come from the 90-99 percentile group, the "B's" from the 60-94 percentile group, the "C's" from the 25-74 percentile group, and "D's" and "F's" from the 0-35 percentile group.

At 93 percentile, a 3 point difference in the raw test score would affect the percentile score by slightly less than 3 percentile points. With a 3 point standard error of measurement on the IAAT, a student of actual 93 percentile aptitude could have been tested as 90 percentile while a student of 92 percentile aptitude could have been tested at 95 percentile. This accounts for the overlap

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[1]Robert V. Hogg and Allen T. Craig, Introduction to Mathematical Statistics (New York: The MacMillan Company, 1959), p. 236.

[2]Greene and Piper, op. cit., p. 10.

between the minimum score needed to expect an "A" grade and the maximum score needed to expect a "B" grade. At 70 percentile, a 3 point difference in raw test score would affect the percentile score positively by slightly more than 5 percentile points and negatively by slightly less than 10 percentile points. Therefore, an even greater overlap between minimum and maximum scores to indicate "B" and "C" grades could have been expected. A student who scored 60 percentile but with a negative 3 point error would have had actual aptitude of approximately 70 percentile while a student who scored 75 percentile but with a positive 3 point error would have had an actual aptitude of approximately 69 percentile. The overlaps between "C" and "D" and "D" and "F" could be explained in the same way.

An examination of Table I and the supporting Figures 1 through 3 showed that the percentages for grades "A," "B," and "C" are in general conformity with these expectations. Table I shows the per cent of each grade in each course earned by the students in each percentile range. Figures 1 through 3 present the same data graphically. The following statistics were found by examining geometry grades as related to percentile score. Approximately 57 per cent of the "A" grades were in the 90-99 percentile group, with a sharp drop in percentage between the 90-94 group and the 85-89 group. The 60-94 group showed 78 per cent of the

"B's," with 70 per cent in the 70-94 percentile group. The 25-74 percentile group showed 43.8 per cent of the "C's," however, 63 per cent of the "C's" are in the 55-84 group which was not too far from expectations. The pattern for the grades of "D" and "F" did not meet expectations at all since they were distributed throughout the entire range of percentile scores.

The discrepancies in the patterns for the "C," "D," and "F" grades in geometry can be explained in two ways. First, as was pointed out in the literature, there are several factors besides natural ability which can and do affect achievement in mathematics. Second, relatively few students with percentile scores below 50 studied geometry or subsequent mathematics. Both of these factors tended to distort the achievement patterns for "C," "D," and "F" grades that would have been expected if the IAAT results were considered by themselves.

An examination of the data presented in Table I and Figures 1 through 3 concerning advanced algebra and senior mathematics showed the same general patterns and discrepancies to be true in them that were true in geometry. The same explanations of the discrepancies is applicable.

The statement that a positive relationship exists between the IAAT and achievement in high school mathematics is supported by this data. Table II and Figures 4 through 6

TABLE II

THE PROBABILITY THAT A STUDENT FROM EACH PERCENTILE GROUP WILL EARN A GIVEN GRADE

%ile	Per Cent of Each Group Earning Each Grade in														
	Geometry					Advanced Algebra					Senior Mathematics				
Group	A	B	C	D	F	A	B	C	D	F	A	B	C	D	F
95-99	45.7	36.2	14.2	3.8	0.8	41.2	32.4	23.7	2.6	0.0	42.0	38.6	17.1	1.1	1.1
90-94	30.0	44.4	24.6	1.1	0.0	26.0	45.2	21.2	7.5	0.0	33.4	35.9	21.8	7.7	1.3
85-89	21.9	34.9	34.2	9.0	0.0	18.8	34.6	42.6	5.0	0.0	25.8	46.8	22.6	4.8	0.0
80-84	14.2	25.0	50.1	10.0	0.0	7.3	41.8	38.2	12.0	0.9	14.0	34.0	40.0	12.0	0.0
75-79	12.8	27.7	50.0	8.1	1.4	7.3	26.0	51.0	13.5	2.1	14.3	25.0	60.7	0.0	0.0
70-74	5.3	22.2	52.2	20.4	0.0	11.8	25.6	39.2	23.6	0.0	0.0	27.3	45.4	18.2	9.1
65-69	7.8	23.4	42.2	26.6	0.0	3.6	20.0	47.3	29.1	0.0	0.0	20.0	46.7	33.3	0.0
60-64	3.9	10.4	44.2	39.0	2.6	0.0	17.1	58.5	22.0	2.4	7.7	23.0	15.4	46.2	7.7
55-59	0.0	17.6	41.2	41.2	0.0	0.0	10.0	50.0	40.0	0.0	0.0	0.0	100.0	0.0	0.0
50-54	2.3	15.8	43.2	38.6	0.0	0.0	11.5	61.5	19.4	7.7	0.0	25.0	75.0	0.0	0.0
45-49	5.6	33.3	30.6	30.6	0.0	9.5	23.8	28.6	33.4	4.8	0.0	100.0	0.0	0.0	0.0
40-44	3.0	9.1	42.4	33.3	12.1	0.0	33.3	0.0	44.4	22.2	0.0	0.0	50.0	50.0	0.0
35-39	0.0	6.7	40.0	46.6	6.7	0.0	0.0	66.7	33.3	0.0	0.0	0.0	0.0	0.0	0.0
30-34	0.0	18.7	18.7	62.5	0.0	0.0	16.7	33.3	41.6	8.3	33.3	33.3	33.3	0.0	0.0
25-29	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20-24	0.0	0.0	23.0	69.2	7.7	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5- 9	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0- 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

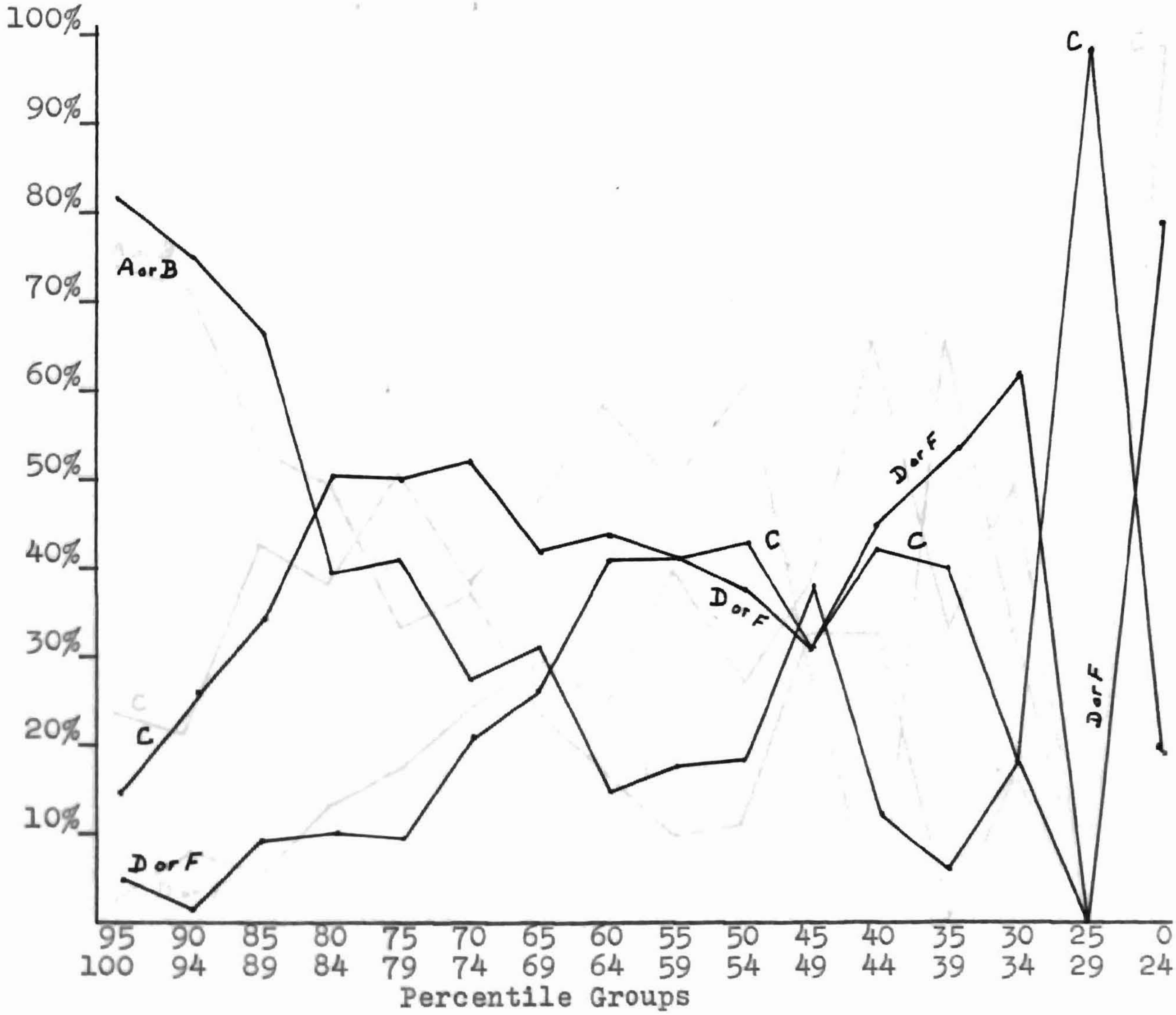

Figure 4. The per cent of each percentile group who earned the indicated grade in geometry.

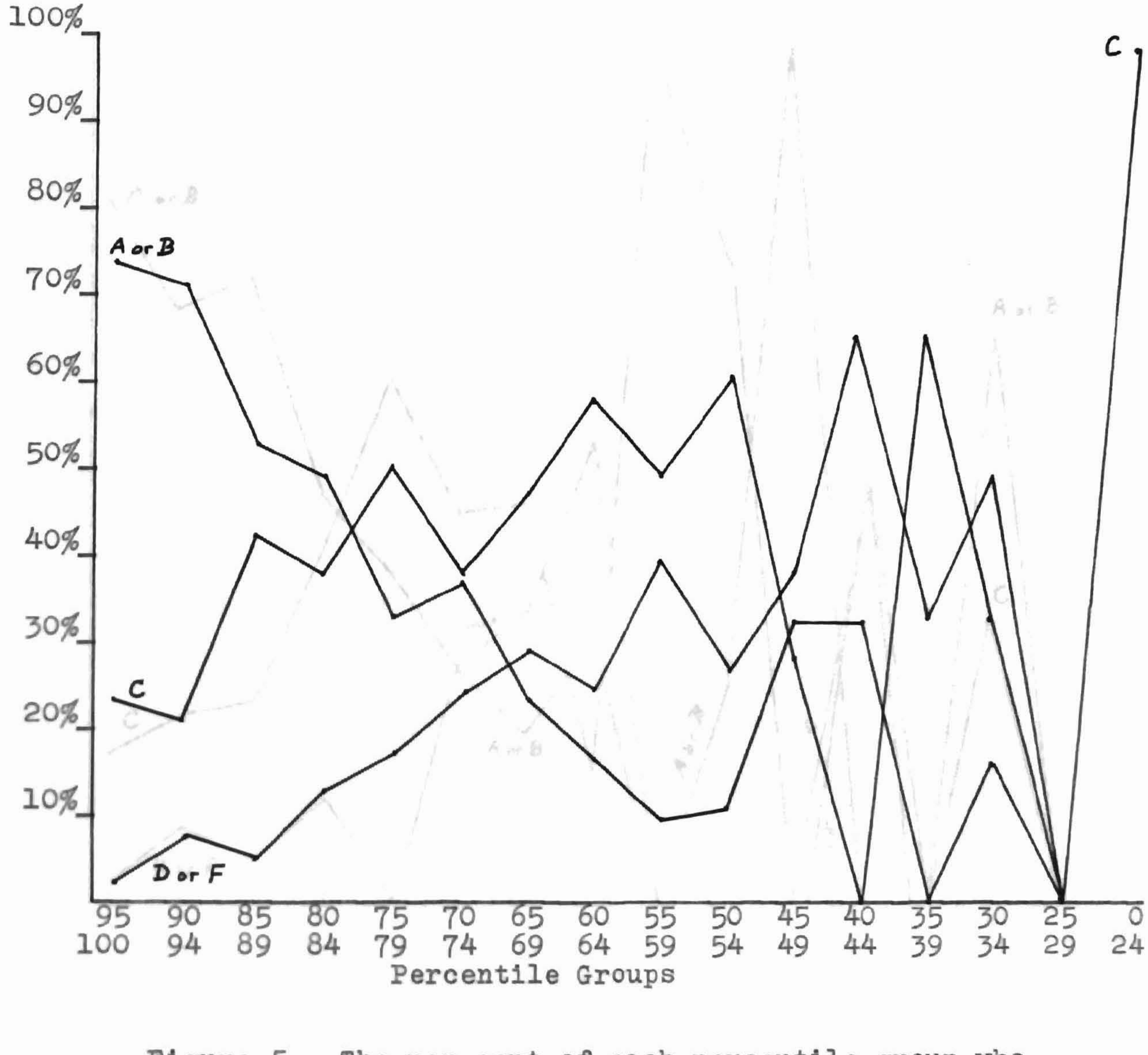

Figure 5. The per cent of each percentile group who earned the indicated grade in advanced algebra.

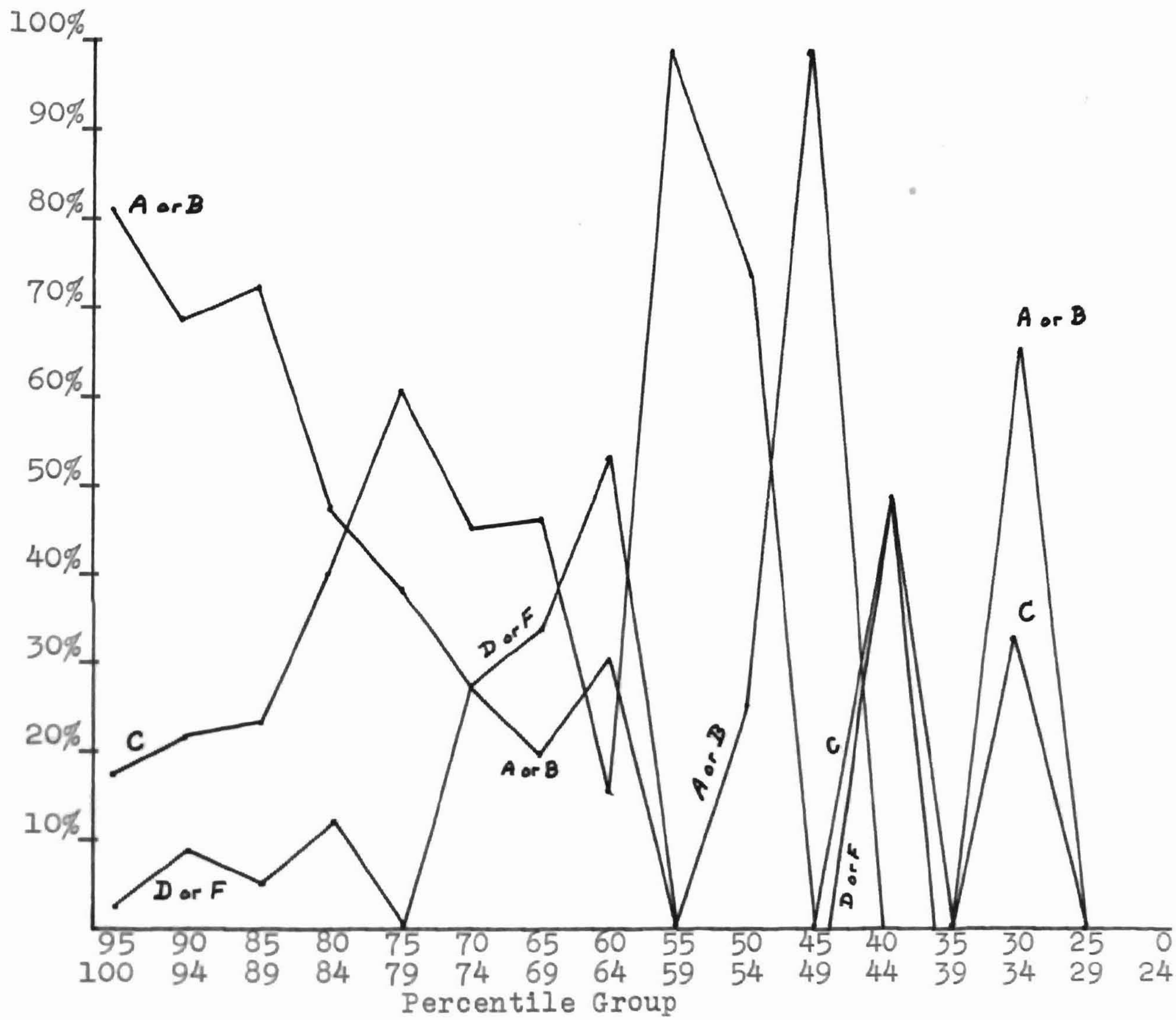

Figure 6. The per cent of each percentile group who earned the indicated grade in senior mathematics.

also support the existence of a relationship between the aptitude test and achievement.

The relationship is expressed in Table II as the probability, based on percentages, of earning a certain grade if one's score on the aptitude test fell in the different percentile groups. Figures 4 through 6 are graphical representations of Table II. These statistics are the converse of those presented in Table I and Figures 1 through 3. The same logic and expectations applied in evaluating them. A one hundred per cent probability of earning an "A" for those in the 93-100 percentile group and so on would have been expected if a perfect relationship were present and there was no error in measurement.

A comparison of the data presented in Table II and the related Figures 4 through 6 with the expected results was favorable, although not perfect. The students with the highest probability of earning an "A" in any of the subjects were in the 95-99 percentile group. Those with the best chances of earning a "B" were in the 75-99 percentile group. Those with the best chances of earning a "C" were in the 35-89 percentile group while those with a relatively high probability of earning a "D" were in the 64 percentile and below group. These comparisons indicate the existence of a positive relationship, although not a perfect one, between the IAAT and mathematical achievement.

That the relationship is not perfect was emphasized by the high number of students with percentile scores above 75 who earned "C's" and the high percentage of students in the 40-74 percentile range who earned "D's." This along with the data in Table I and Figures 1 through 3 indicated the importance of considering other factors such as I. Q., previous achievement, and initiative in attempting to predict a student's achievement in mathematics.

Examination of the probability of a student earning either "A" or "B," (Superior), or "D" or "F," (Unsuccessful), showed that it followed a pattern. The chances of a student earning an "A" or "B" dropped steadily from the 95-99 percentile group down to the 50-54 percentile group. The groups below 50 did not show a consistent pattern. Conversely, the chances of a student earning a "D" or "F" rose steadily as his percentile dropped from the 95-99 percentile group down through the 50-54 percentile group. His chances varied considerably below that. The decrease in probability of earning an "A" or "B" and the increase in probability of earning a "D" or "F" as the percentile score decreases to 50 percentile indicates the existence of a relationship between the IAAT and achievement.

The variation in probabilities for those in the percentile groups below 50 can be explained. There were relatively few students in these groups since many, with percentile scores below 50, apparently realized their chances of earning a "C" grade or better were low and elected not to enroll in these courses. Therefore many of the students with low percentile scores in this study could be considered exceptional cases or at least the more motivated students in the below 50 percentile range.

II. POINTS OF DIVISION ON THE IAAT FOR PREDICTIVE PURPOSES

Besides examining the existence of a relationship between the IAAT and mathematical achievement, another important aspect of the evaluation was to investigate the existence of distinct division points for predicting various degrees of achievement. Table III was developed for this purpose. The table has two parts. The first shows the percentile ranges for all grades in each subject. The percentile ranges excluding the extreme two per cents were also figured. This was done to obtain a statistic that was less distorted by exceptional cases. It was decided to exclude the extreme two per cents because these would represent variance from the mean of more than two standard deviations on a normal curve.

By using the lower limit of the percentile range for each grade in each course as a point of division, the

TABLE III

THE MINIMUM-MAXIMUM PERCENTILE SCORE RANGE OF STUDENTS EARNING EACH GRADE IN THE HIGH SCHOOL MATHEMATICS COURSES

Part A:
Complete range.

Courses	A	B	C	D	F
Geometry	40-99	30-99	20-98	8-99	22-95
Advanced Algebra	46-99	30-99	20-99	30-97	34-80
Senior Mathematics	30-99	30-99	30-99	40-97	60-97

Part B:
Range excluding the extreme two per cents. The number in parentheses indicates the number of students excluded at each extreme.

Courses	A	B	C	D	F
Geometry	62-99(4)	45-98(7)	35-95(9)	20-90(4)	22-95(0)
Advanced Algebra	60-99(3)	45-99(5)	35-97(6)	30-95(2)	34-80(0)
Senior Mathematics	75-99(2)	48-99(3)	50-99(2)	60-94(1)	60-97(0)

following statement can be made. Only in exceptional cases will a student earn an "A," "B," or "C" in the various subjects if his percentile score falls below the indicated minimum percentile score for that grade in each subject. This is shown in Table IV.

TABLE IV

MINIMUM PERCENTILE SCORE FOR EACH GRADE INDICATED

Course	A	B	C
Geometry	62	45	35
Advanced Algebra	60	45	35
Senior Mathematics	75	48	50

Only in exceptional cases did a student with a percentile score lower than the minimum score listed for each grade earn that grade or better.

It is also important to note that the maximum percentile score for the range of each grade as shown in Table III was 94 or above with only two exceptions. The maximum for a "D" in geometry was 90 percentile and the maximum for an "F" in advanced algebra was 80 percentile. This indicated that although in general a high percentile score on the IAAT is necessary to indicate superior achievement in mathematics, it is not sufficient.

A conclusion similar to that reached with the data from Table IV resulted from analyzing the data presented in Table V. Very few of the students who earned "A" or "B," (Superior), grades in geometry had percentile scores below 65. In fact, 90 per cent of the students receiving superior grades had percentile scores of 66 or above. In advanced algebra, 90 per cent of the students with superior achievement were above the 70th percentile and in senior mathematics, 90 per cent of the students with superior marks had percentile scores above 76 percentile.

Picking a percentile score in the sixties as a division point for predicting superior achievement was indicated, after examining the achievement of students whose IAAT scores were below 65 percentile. Only 17.2 per cent of the students with percentile scores below 65, who took geometry, earned grades of "A" or "B" while 43.9 per cent got grades of "D" or "F."

It is important to remember that a natural selection process had taken place to distort the percentages, especially for the lower percentile groups. Many of the poorer mathematics students whose percentile scores were below 65 did not take geometry or higher mathematics. This means only 17.2 per cent of the better students with scores below 65 percentile got an "A" or "B" and 43.9 per cent of the better students in that group earned a "D" or "F."

TABLE V

NUMBER OF STUDENTS IN EACH PERCENTILE GROUP WHO EARNED THE INDICATED GRADE IN EACH COURSE

%ile Groups	No. Students Geometry			No. Students Advanced Algebra			No. Students Senior Mathematics		
	A&B	C	D&F	A&B	C	D&F	A&B	C	D&F
95-99	104	18	5	84	27	3	71	15	2
90-94	139	46	2	104	31	11	54	17	7
85-89	70	42	11	54	43	5	45	14	3
80-84	58	75	15	54	42	14	24	20	6
75-79	60	74	14	32	49	15	11	17	0
70-74	31	59	23	19	20	12	3	5	3
65-69	28	38	24	13	26	16	3	7	5
60-64	11	34	32	7	24	10	4	2	7
55-59	6	14	14	1	5	4	0	2	0
50-54	8	19	17	3	16	7	1	3	0
45-49	14	11	11	7	6	8	4	0	0
40-44	4	14	15	3	0	6	0	1	1
35-39	1	6	8	0	2	1	0	0	0
30-34	3	3	10	2	4	6	2	1	0
25-29	0	2	0	0	0	0	0	0	0
20-24	0	3	10	0	2	0	0	0	0
15-19	0	0	0	0	0	0	0	0	0
10-14	0	0	0	0	0	0	0	0	0
5-9	0	0	3	0	0	0	0	0	0
0-4	0	0	0	0	0	0	0	0	0
Total	537	458	214	383	297	118	222	104	34

The fact that this selection process was taking place was illustrated by the percentages from advanced algebra and senior mathematics. The per cent of students earning "A" or "B" rose to 18.5 for advanced algebra and to 39.3 per cent in senior mathematics. At the same time the per cent of students earning "D" or "F" in advanced algebra dropped to 33.8 and to 28.6 in senior mathematics.

III. USEFULNESS OF THE IAAT FOR PREDICTION

The last point in evaluating the IAAT as a tool for predicting achievement in high school mathematics was to determine if the relationship between the IAAT and achievement could be expressed in a manner meaningful to guidance counselors, teachers, and students in terms of helping each student make more informed choices as to which course of study he wished to pursue.

The data presented in the preceeding tables is of this type. It shows in general terms, given a student's IAAT percentile score, a student's chances or probability of reaching any particular level of achievement in his mathematics. Two other tables were developed with this particular objective in mind. The data presented in Table VI shows the minimum percentile score on the IAAT for descending probabilities of doing superior or successful work in high school mathematics above first year algebra.

The data presented in Table VI did not yield any significant results. This was due to the preponderance of scores in the upper percentile ranges. The numbers of superior and successful students in the upper percentile ranges greatly overbalanced the effects on the percentages of adding the results of students from the lower percentiles.

TABLE VI

MINIMUM IAAT PERCENTILE SCORE FOR DESCENDING PROBABILITIES OF SUPERIOR OR SUCCESSFUL WORK

Prob. of Level of Achievement	Superior Achievement Min. IAAT Score	Prob. of Level of Achievement	Successful Achievement Min. IAAT Score
90.0%	99%ile	90.0%	74%ile
80	97	80	49
70	96	77.8	0
60	86		
50	79		
40	66		
35	50		
32.7	0		

The data as presented in Table VII did appear useful for evaluating a student's probability of reaching a superior or successful level of achievement in high school mathematics. In this table, the students were grouped in five percentile ranges according to their score on the IAAT. Then their overall grade average for all high school

TABLE VII

PERCENTAGE OF STUDENTS FROM EACH PERCENTILE GROUP WHO REACHED THE INDICATED LEVEL OF ACHIEVEMENT

%ile Group	Superior %age Students	Superior No. of Students	Successful %age Students	Successful No. of Students	Unsuccessful %age Students	Unsuccessful No. of Students
95-99	68.3%	43	28.6%	18	3.2%	2
90-94	63.4	59	31.2	29	5.4	5
85-89	41.0	27	50.0	33	9.1	6
80-84	28.9	22	59.3	45	11.8	9
75-79	28.9	22	56.6	43	14.5	11
70-74	17.6	10	47.4	27	35.0	20
65-69	13.3	6	57.8	26	28.9	13
60-64	7.7	3	41.0	16	51.3	20
55-59	5.9	1	41.2	7	52.9	9
50-54	4.5	1	59.1	13	36.4	8
45-49	26.3	5	26.3	5	47.4	9
40-44	11.1	2	22.2	4	67.7	12
35-39	0.0	0	50.0	4	50.0	4
30-34	12.5	1	25.0	2	62.5	5
25-29	0.0	0	100.0	1	0.0	0
20-24	0.0	0	14.3	1	85.7	6
15-19	0.0	0	0.0	0	0.0	0
10-14	0.0	0	0.0	0	0.0	0
5-9	0.0	0	0.0	0	100.0	2
0-4	0.0	0	0.0	0	0.0	0

mathematics above first year algebra was computed and recorded as superior, successful or unsuccessful. The per cent of students in each percentile range who reached the three levels of achievement was computed. These percentages showed the same pattern that was found in the other examinations of the data. It appeared that these percentages or probabilities could be very useful in counseling students about the future study of mathematics. The results are listed in Table VII.

Because of the relatively low number of students with IAAT scores below 65 percentile, two additional statistics were figured. One group was formed by combining all those with percentile scores between 35 and 64. Of this group, 9.8 per cent had superior achievement, 39.8 per cent had successful achievement and 50.4 per cent performed unsuccessfully. A second group of those in the 0-34 percentile range was formed. In this group 3.8 per cent did superior work and 65.4 per cent were unsuccessful in studying high school mathematics.

CHAPTER IV

CONCLUSIONS AND RECOMMENDATIONS

Three points were considered in evaluating the IAAT as a predictor of success in high school mathematics above first year algebra. These were to determine the existence of a positive relationship between the test and achievement in mathematics, the existence of points of division for predicting levels of achievement, and a way of presenting the relationship, if it existed, so that it was meaningful to guidance counselors, teachers, and students. The literature and data supported the existence of a positive relationship, the existence of the dividing points, and showed a meaningful way of presenting the relationship.

The Examiner's Manual for the IAAT points out that the test is the result of extensive study and examination. Its contents test those factors that the literature indicates as important aspects of raw mathematical ability. It has also been shown to correlate well with other known measures of mathematical achievement. It was shown that in general the higher a student's percentile score on the IAAT, the greater his chances were of doing superior work. It was also found that a low score on the test indicated very high probability of unsuccessful performance.

The literature and the data indicated that the IAAT cannot be used without considering other factors to make accurate predictions. It was found that the presence of raw mathematical ability as indicated by the test was necessary with few exceptions for a student to achieve superior performance. However, the presence of that ability did not insure superior or even successful performance.

Previous achievement in mathematics, I. Q., and initiative were found to be important contributors to success. The data showed that these could be especially important considerations in predicting achievement for students with percentile scores in the 30-80 percentile range.

The writer feels that when the IAAT results are used in conjunction with these other factors, reasonably accurate predictions can be made. For example, Table VII showed that a student with a percentile score in the 70-75 range had approximately a 70 per cent chance of doing successful or better work in mathematics. If these other factors are considered, the seven out of ten who will succeed and the three who will not should be fairly easy to identify.

Several division points for predicting levels of achievement were located. Only in very exceptional cases will students with a percentile score below 60 earn an "A" grade. Similarly, the minimum for a "B" grade was found to be 45 percentile, and the minimum for a "C" grade was found to be 35 percentile.

Depending on the degree of accuracy required, other division points were found. Students who score above 90 percentile on the IAAT have a little better than 60 per cent probability of doing superior work and better than 95 per cent chance of doing at least successful work. Those who score below 65 percentile have less than a 10 per cent chance of doing superior work and a little over 50 per cent chance of doing unsuccessful work. Almost two-thirds of the students scoring below 35 percentile will be unsuccessful.

The third point of evaluation was whether the relationship between the IAAT and achievement could be expressed in a manner that would be meaningful and useful for predicting future mathematical success. The writer believes that the data was presented in this study in a manner which met the requirement of usefulness.

This study has not attempted to make more than very general statements about how the IAAT could be used as a predictive tool. This was due to the possibility of several objectives which might require prediction or selection. These could include selection for ability grouping, selection for accelerated mathematics curricula, as well as for deciding whether or not to continue the study of mathematics. The requirements of each individual using the test could also vary. Some might feel that a fifty-fifty probability of success was enough information for the choice, while others might require seventy-thirty or even higher. The other factors listed earlier as important to mathematical achievement also affect each individual's requirements in using the IAAT to predict success.

In this study and the literature it was found that:

1. There is definitely a positive relationship between the IAAT and achievement in high school mathematics above first year algebra.
2. There are several division points for prediction.
   Very few students who score above 90 percentile on the IAAT will not do at least successful work in mathematics. In general a percentile score on the IAAT of 65 or higher is necessary but not sufficient alone for superior performance in mathematics. Only in exceptional cases will students who score below 65 percentile do successful or better work in mathematics.

   Although other division points were found, they are not listed because of the varying requirements that result from different predictive problems.
3. It is possible to use certain percentile scores on the IAAT as points of division for purposes of prediction and selection.
4. The IAAT can definitely serve as a useful tool for

of success [illegible] information for the choice, while others [illegible] seventy-thirty or even higher. The other factors listed earlier as important to mathematical achievement also affect an individual's requirements in using the IAAT to predict success.

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1. There is definitely a positive relationship between the IAAT and achievement in high school mathematics above first year algebra.
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   Although other division points [illegible], they are not listed because of [illegible] result from different [illegible].
3. It is possible to use [illegible] on the IAAT as points of [illegible] prediction and selection.
4. The [illegible] serve as a useful tool for

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